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Aquatic and Terrestrial Habitat Resources

National Biology Handbook

Issued November 2004

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Mission of the NRCS:
The Natural Resources Conservation Service provides leadership in a partnership effort to help people conserve, maintain, and improve our natural resources and environment.

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National Biology Handbook

Aquatic and Terrestrial Habitat Resources

Contents:

Subpart A General Information

Part 600 Introduction
Part 601 Conservation Partnerships
Part 602 Training Opportunities

Subpart B Conservation Planning

Part 610 Ecological Principles for Resource Planners
Part 611 Conservation Planning for Integrating Biological Resources
Part 612 Fish and Wildlife Habitat in Ecological Site Descriptions
Part 613 Conservation Corridor Planning at the Landscape Level—Managing for Wildlife Habitat

Subpart C Technical Resources

Part 620 Technical References for Integrating Fish and Wildlife Considerations into Conservation Planning
Part 621 Technical Guidance Documents
Part 630 Exhibits

United States
Department of
Agriculture

**Natural
Resource
Conservation
Service**

National Biology Handbook

Aquatic and Terrestrial Habitat Resources

Subpart A General Information

600.00 Introduction

Biological resources include all living things from bacteria and fungi to plants, insects, and other invertebrates, reptiles, amphibians, fish, birds, and mammals, including humans. The focus of this handbook is primarily on fish and wildlife resources, how they relate to the environments in which they occur, and how these resources can be integrated into the conservation planning process.

While the environment that NRCS helps its clients conserve, maintain, and improve supports a productive generator of food and fiber for the benefit of society, it is also habitat for fish and wildlife and other biological resources. There is no inch of our environment that is not habitat for some living organism. This maxim is simple to understand. What is not so simple in a complex world of cultures, societies, human needs, and resource economics is how to integrate fish, wildlife, and plant habitat considerations into resource conservation actions. Habitat is everywhere we are asked to go to provide technical assistance in natural resource conservation.

Today, more and more of our environment, and thus habitat, is in poor condition or unsuitable to support desirable fish and wildlife resources. Human land uses have tended to simplify, fragment, and degrade habitats and the biological communities that depend on them (fig. 600–1).

This handbook will help conservationists effectively and efficiently integrate the habitat considerations of fish and wildlife and other biological resources into conservation plans for farms, ranches, backyards, city parks, rangelands, streams, rivers, lakes, wetlands, estuaries, and riparian areas. Habitats are components of living landscapes, and their conservation is critical to all living things, including humans. Thus, humans cannot set themselves apart from impacts that result from their conservation decisions.

Figure 600–1 Poor land management leads to simplification and degredation of habitat at the site and within the broader landscape (photo courtesy USDA NRCS)

Habitats are not discrete biological units, nor are farms and ranches. These sites are immersed spatially and temporally into ecosystems and landscapes (fig. 600–2). Thus, conservation of biological resources requires a holistic approach to planning.

Animals, be they terrestrial or aquatic, move. Their food sources move or are affected by elements in the landscape. Habitats influence and are influenced by the surrounding landscape of which they are a part.

Figure 600–2 Working lands provide habitat at the site and connect habitats to broader landscapes (photo courtesy Lynn Betts, USDA NRCS)

Considering landscapes when planning saves the conservationist and the landowner time and money, especially in the long term.

As conservationists provide technical assistance to landowners, they need to play the role of natural resource specialist, facilitator, and planning advisor. The needs and desires of the landowner must be respected, and the needs of the biological community within the property and beyond its borders considered.

Technical assistance is diligently offered at a local scale with the greater landscape in mind. The needs of fish and wildlife are better integrated with the objectives of landowners if the conservationists thinks of working lands as habitats (fig. 600–3). Considering habitat components in an environmental context relevant to humans should be considered when planning at a local scale.

The scope of habitat conservation is large. National Initiatives that focus on biological resources and their habitats include those for Conservation Buffers, Invasive Species, Clean Water and Air, Threatened and Endangered Species, Wetland and Wildlife Habitat Restoration and Conservation, Drought Protection, and Upland Watershed Protection.

The purpose of this handbook is to provide field office personnel a well-organized and comprehensive compilation of key technical information needed to integrate

Figure 600–3 Habitat considerations for fish and wildlife should be linked to environmental conditions of working lands

Consider	**Habitat**	**=**	**Environment of working land**
	Biotic community		Farm, ranch, acreage, backyard
Evaluate	Habitat condition, ecological setting, food source, and cover	➡	Site uses, ecosystem, landscape conditions, matrix type, patch size, and connectivity
Integrate	Fish and wildlife needs	**with**	Landowner objectives, economics, and capability of the land

fish, wildlife, and plant habitat considerations into resource conservation on working lands. Conservation of the biological resources and stewardship of their habitats is everybody's responsibility. This cannot be carried out without the technical, financial, and regulatory support of our Conservation Partners. For this reason, an entire section (part 601) of this handbook provides information on how to develop partnerships to leverage time and money, and be as effective as possible in delivering fish and wildlife habitat conservation on working lands.

In addition, the handbook provides a framework to which state-specific technical guidance related to habitat considerations can be incorporated. This handbook should be used in conjunction with the National Biology Manual, which has the NRCS policies that guide the management of fish and wildlife resources.

The materials in this handbook are designed and presented in a format that provides the conservationist with a consistent and efficient means to determine how to plan and implement habitat-related conservation on the ground, in the environments provided by the working lands of our customers.

Timely transfer of technical resources and guidance to land managers and conservation planners is now easier with the development of online resources. This handbook is available online and will be updated periodically to reflect new science and technology associated with managing lands with fish and wildlife in mind.

United States
Department of
Agriculture

**Natural
Resources
Conservation
Service**

National Biology Handbook
Subpart A—General Information

Part 601 Conservation Partnerships

(190-VI-NBH, November 2004)

Part 601 Conservation Partnerships

Contents:

601.00	**Introduction**	**601–1**
601.01	**Why partnerships?**	**601–1**
601.02	**National conservation partnership**	**601–5**
601.03	**Other partnerships**	**601–6**
	(a) Fish and wildlife habitat partnerships	601–6
	(b) National MOUs	601–7

Tables

Table 601–1	Comparison of attributes of successful and unsuccessful partnerships	601–3
Table 601–2	Common types of instruments used by NRCS to forge partnerships with other entities to meet fish and wildlife habitat and other conservation objectives	601–4
Table 601–3	The National Conservation Partnership	601–5

Figure

Figure 601–1	The foundation for successful partnerships represented by eight primary factors	601–2

Cover photos courtesy Dot Paul, USDA NRCS, and the NRCS West Region Biology Consortium, Utah

601.00 Introduction

The mission of NRCS is to work on the Nation's non-Federal lands to conserve, improve, and sustain natural resources. The agency emphasizes voluntary, science-based assistance, partnerships, and cooperative problem solving at the community level. To carry out its mission, the Agency works in partnership with owners and operators of non-Federal lands, providing resource inventories and assessments and conservation planning technical assistance.

One of the four goals identified in the 1996 NRCS publication, *Framework for the Future of Wildlife*, is to use partnerships for delivery and enhancement of quality wildlife planning assistance to NRCS customers.

This document recognized the great potential to use the expertise and resources of numerous fish and wildlife agencies and organizations to enhance the quality of technical assistance that NRCS provides to private landowners and managers. In addition, it recognized the potential for the extensive field network of NRCS conservationists working with farmers and ranchers to advance the goals and objectives of these many fish and wildlife interests.

Development of productive partnerships is the key to maximizing the ability of the NRCS, other fish and wildlife interests, and owners and managers of working lands, to realize fish and wildlife habitat objectives.

NRCS has entered into a wide variety of partnerships at the local, state, and national levels that directly or indirectly enhance the Agency's ability to foster effective conservation of natural resources on non-Federal lands, including management of fish and wildlife resources. Innumerable additional opportunities exist for new fish and wildlife conservation partnerships to be formed.

601.01 Why partnerships?

Partnerships provide an efficient mechanism for an individual or entity to accomplish more than would otherwise be possible if the individual or entity were working alone. Each party brings a unique set of expertise, resources, perspectives, experience, and energy to the partnership, maximizing the effectiveness of achieving common goals.

Successful partnerships are based on mutual understanding, trust, effective communication and collaboration, and shared objectives as shown in figure 601–1. Characteristics of successful partnerships can be explored by comparing attributes of partnerships that have succeeded with those that have failed or have been ineffective (table 601–1).

The primary purposes of NRCS partnerships with other agencies, groups, and individuals follow:

Conservation planning and implementation. Providing conservation planning assistance to farmers and ranchers is a primary NRCS field activity. Through partnerships with other entities, planning assistance can be increased and improved by bringing the expertise and resources of partner agencies and organizations into the planning process.

Monitoring conservation activities and projects. Conservation projects are often easily monitored and managed by local partner organizations or individuals. Where partners have a stake in the conservation work accomplished, the quality of followup monitoring to ensure conservation goals are met is typically very high.

Project funding and implementation. Sharing project costs may be the most recognized partnership purpose. In general, greater conservation accomplishments are possible where several funding sources contribute.

Program coordination and delivery. Coordination and delivery of conservation programs presents a significant workload challenge in many areas. Partner agencies and organizations that have a technically sound field presence can greatly assist with this heavy workload while meeting shared conservation objectives.

Technical assistance. Each partner organization typically possesses a unique area of technical expertise. This expertise can be applied directly or indirectly to NRCS activities through partnerships.

Technology development. As with technical assistance, the technical expertise of various partner entities can be used to develop technical tools and training programs to improve the quality of technical assistance provided to NRCS clients.

Common mechanisms used to forge partnerships. Several types of instruments are used to forge conservation partnerships between NRCS and farmers and ranchers, other governmental agencies, private organizations, and other entities. It is important to use the proper instrument in developing partnerships with other entities. Table 601–2 provides general guidance on where to use the various types of instruments. Additional guidance should be sought from NRCS contract specialists as appropriate.

Figure 601–1 The foundation for successful partnerships represented by eight primary factors (adapted from Nebraska Cooperative Extension Publication NF96-262)

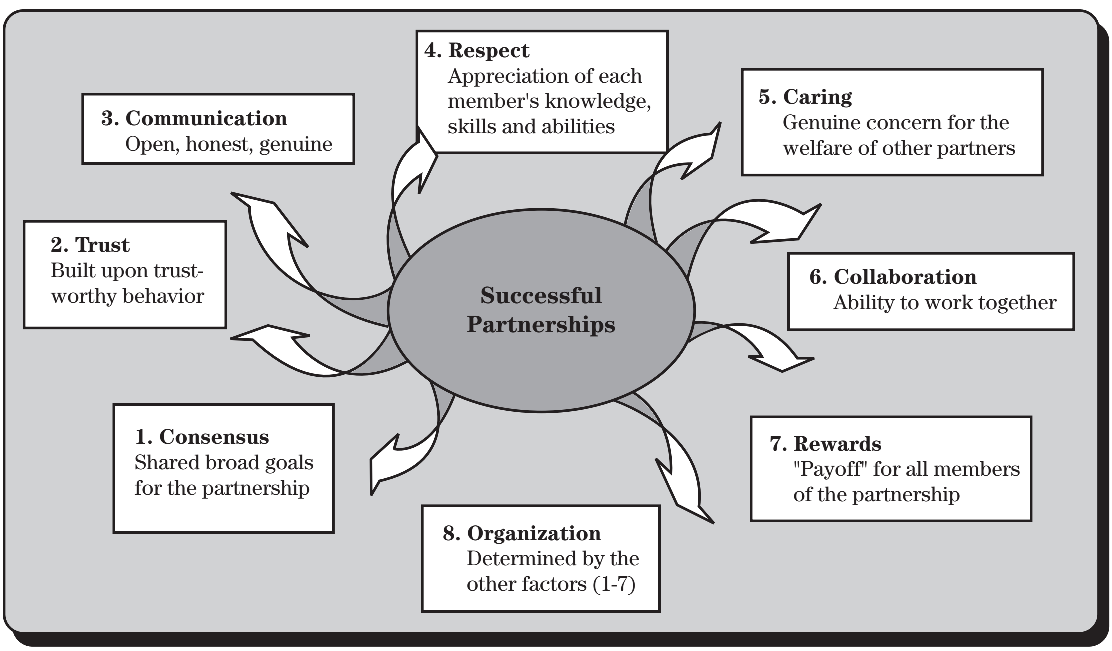

Table 601–1 Comparison of attributes of successful and unsuccessful partnerships

Successful	Unsuccessful
Development of compatible ways of working and flexibility	One partner manipulates or dominates
Good communication	Lack of clear purpose
Collaborative decisionmaking, with a commitment to achieving consensus	Unrealistic goals
Effective organizational management	Differences of philosophy and ways of working
Agreement that a partnership is needed	Lack of communication
Respect and trust among parties	Unequal and unacceptable balance of power and control
Complementary resources	Key interests missing from the partnership
Leadership of respected individual or individuals	Hidden agendas
Commitment of key interests developed through a clear and open process	Financial and time commitments outweigh the potential benefits
Development of a shared vision for the partnership and what might be achieved	A history of conflict among key interests
Adequate time taken to build the partnership	

Table 601–2 Common types of instruments used by NRCS to forge partnerships with other entities to meet fish and wildlife habitat and other conservation objectives

Type of instrument	Use
Memorandum of understanding	Provides a plan for joint sharing in the operation of a project or undertaking. Each party carries out its responsibilities by using its own authorities and resources, including funding. No financial or other resources are directly obligated, transferred, or exchanged between the parties.
Joint agreement	Provides structure for parties to share responsibility for planning and carrying out a project or undertaking. Each party is responsible for doing their own part, and each party contributes funds or other tangible resources to the project. Party contribution may not necessarily be equal so long as they carry out their own role. Joint agreements may be with other Federal agencies, State or local governments, and other entities and individuals.
Contribution agreement	A relationship in which one or more non-Federal party contributes funds or other resources to NRCS so NRCS can accelerate an ongoing activity.
Interagency agreement	Joint or cooperative ventures in which each agency contributes to part of the cost of a project or undertaking, with funding separated and each agency's responsibilities spelled out. Each participating agency must have a program authority for the undertaking.
Grants	Reflect a relationship between NRCS and a State, local government, or other recipient where the purpose is to transfer a thing of value to a recipient to gain public support or stimulation authorized by Federal law and substantial Federal involvement **is not** anticipated.
Cooperative agreements	Reflects an assistance relationship between NRCS and a State, local government, or other recipient where the purpose is to transfer a thing of value to a recipient to gain public support or stimulation authorized by Federal law and substantial Federal involvement **is** anticipated.

For additional information on the use of these instruments and other related subjects (e.g., contracts), refer to NRCS General Manual, Title 120 Administrative Services.

601.02 National conservation partnership

A primary mechanism used to deliver technical assistance to non-Federal landowners and operators is the National Conservation Partnership. This partnership is a dynamic relationship among federal, state, and nonprofit groups that have pledged to jointly provide national conservation leadership. The partnership was formalized in January 1993 when three conservation leaders signed a national agreement, pledging to work together for natural resource conservation. A fourth partner was added in 1997. Independently, partnership members have separate responsibilities for sustaining the environment and conserving the Nation's natural resources. As partners in conservation, they speak with a unified voice and act to realize a common vision: a productive nation in harmony with a quality environment (table 601–3).

The national conservation partnership involves:

- Listening and responding to customers' local resource conservation needs
- Fostering economically viable environmental policies
- Advocating a total natural resources approach to conservation
- Maintaining and advocating grass roots conservation delivery systems

Table 601–3 The National Conservation Partnership

Conservation partnership member	Conservation partnership role
NRCS	As the Federal agency with the lead in assisting the American people to conserve natural resources on private lands, NRCS brings over 60 years of scientific and technical expertise to the partnership.
National Association of Conservation Districts (NACD)	NACD is the national organization for 3,000 local conservation districts across the country. Conservation districts are local units of government responsible for the soil and water conservation work within their boundaries. The districts' role is to increase voluntary conservation practices among farmers, ranchers, and other land users.
National Association of State Conservation Agencies (NASCA)	NASCA is a coalition of state conservation agencies across the country. These agencies provide guidance and funding for conservation districts. They operate numerous state environmental, sediment control, and soil erosion prevention programs.
National Association of Resource Conservation and Development Councils (NARC & DC)	NARC&DC provides a collective voice for more than 300 local Resource Conservation and Development councils nationwide. The NARC&DC serves as an advocate and assists local councils to identify and take action on issues and opportunities to improve the quality of life and environment in their communities. Local RC&D councils are grass-roots community leaders working collectively on behalf of conservation and sustainable development.

601.03 Other partnerships

While the National Conservation Partnership strives to address a broad range of natural resource conservation issues on non-Federal lands, the Agency is engaged in numerous other partnerships to address effectively the full range of issues necessary to carry out its mission. Along with individual owners and operators of non-Federal lands, NRCS' conservation partners also include:

- Conservation districts
- Local communities
- State and Federal agencies
- Native Hawaiians, Alaskans, and Tribes
- Agricultural and environmental groups
- Conservation organizations
- Professional societies
- NRCS Earth Team volunteers
- RC&D councils
- Watershed councils and associations
- Agribusiness
- Schools and universities

(a) Fish and wildlife habitat partnerships

Many partnerships are developed either for the purpose of or have the potential of benefiting fish and wildlife resources on private lands. Partnerships have been developed around funding and delivery of specific programs, such as agreements with State agencies to implement Conservation Reserve Enhancement Programs, as well as around more generic technical assistance objectives.

Opportunities for partnerships identified by fish and wildlife interests outside NRCS (adapted from Framework for the Future of Wildlife) include:

- Sharing employees through details and interagency personnel agreements
- Recruiting new partners from diverse sectors, including corporations and industry
- Increasing networking through workshops and demonstration projects
- Developing agreements based on funding and donation of time and materials
- Nurturing results-oriented partnerships through embracing the various motives, resources, and objectives of parties
- Soliciting partner input of information into the NRCS Field Office Technical Guide
- Serving on State Technical Committees to engender field input
- Conducting region-specific technical meetings and retreats
- Inviting partners to assist in training NRCS personnel on fish and wildlife issues

Examples of broad-based fish and wildlife partnerships follow.

North American Waterfowl Management Plan— The North American Waterfowl Management Plan (NAWMP) was launched in 1986 with the signing of an agreement between the United States and Canada. Mexico joined the program in 1988. NAWMP provides a policy framework for analyzing North American waterfowl issues. It sets out a number of objectives relating to waterfowl habitat and populations, with a focus on conserving and expanding wetland areas.

NAWMP is based on the principle of joint ventures that serve as a framework for the activities of its private and regional member agencies. These partners coordinate their efforts in the pursuit of common objectives for waterfowl protection in each region, province, or state. The goals of NAWMP extend beyond waterfowl to include all wetland wildlife resources.

North American Bird Conservation Initiative— The vision of North American Bird Conservation Initiative (NABCI) is to see populations and habitats of North America's birds protected, restored, and enhanced through coordinated efforts at international, national, regional, state, and local levels, guided by sound science and effective management. NABCI-US seeks to accomplish this vision through:

- Broadening bird conservation partnerships
- Working to increase the financial resources available for bird conservation in the United States and wherever these birds may occur throughout their life cycle

- Enhancing the effectiveness of those resources and partnerships by facilitating integrated bird conservation

The efforts of NABCI are intended to integrate the bird conservation work associated with implementation of the NAWMP, the U.S. Shorebird Conservation Plan, the North American Colonial Waterbird Conservation Plan, and Partners in Flight. Productive and creative conservation partnerships are the fuel that drives all of these efforts.

Partners in Amphibian and Reptile Conservation—The mission of Partners in Amphibian and Reptile Conservation (PARC) is to conserve amphibians, reptiles, and their habitats as integral parts of our ecosystem and culture through proactive and coordinated public/private partnerships. PARC represents the most diverse group of individuals and organizations ever to work together to address problems confronting reptiles and amphibians on a national and global scale.

To maintain this strength, and to enhance it in the future, membership in PARC is open to all persons, businesses, and organizations that share a commitment to herpetofaunal conservation through cooperative means, and who can bring resources to PARC in support of this objective.

North American Bat Conservation Partnership—
The North American Bat Conservation Partnership (NABCP) is a program to promote more effective protection of bats and their habitats through the collaboration of bat researchers, private organizations and foundations, corporations, and government agencies in Mexico, Canada, and the United States.

The NABCP seeks to develop, through its partners:

- A continental strategy for bat conservation
- Improved conservation efforts through increased communication
- Efficiently delivered resources and matching funds for bat-related projects in the field

(b) National MOUs

NRCS has entered into Memoranda of Understanding (MOU) with fish and wildlife organizations at the national level to formalize the productive working partnership it shares with these entities. These MOUs establish the general framework of cooperation between the parties to foster better conservation and fish and wildlife management on private lands. Copies of national MOUs are filed as exhibits in the National Biology Manual.

The following pages have national and regional fish and wildlife-oriented partner organization names and contact information. As of December 2003, NRCS had national MOUs with entities identified with an asterisk.

National Fish and Wildlife-Oriented Partner Organizations

(* indicates National MOU with NRCS, ** indicates National MOU with NRCS in development)

American Fisheries Society
5410 Grosvenor Lane, Suite 110
Bethesda, MD 20814-2199
(301) 897-8616
www.fisheries.org

Bat Conservation International *
P.O. Box 162603
Austin, TX 78716
(512) 327-9721
www.batcon.org

The Conservation Fund
1800 N. Kent Street, Suite 1120
Arlington, VA 22209-2156
(703) 525-6300
www.conservationfund.org

Ducks Unlimited *
One Waterfowl Way
Memphis, TN 38120
(901) 758-3825
www.ducks.org

International Association of Fish and Wildlife Agencies
444 North Capitol Street, NW, Suite 544
Washington, DC 20001
(202) 624-7890
www.iafwa.org

National Audubon Society **
700 Broadway
New York, NY 10003
(212) 979-3000
www.audubon.org

National Association of Conservation Districts *
509 Capitol Court, NE
Washington, DC 20002-4946
(202) 547-6223
www.nacdnet.org

National Fish and Wildlife Foundation *
1120 Connecticut Avenue, NW, Suite 900
Washington, DC 20036
(202) 857-0166
www.nfwf.org

National Wild Turkey Federation *
P.O. Box 530
Edgefield, SC 29824
(803) 637-3106
www.nwtf.org

National Wildlife Federation
8925 Leesburg Pike
Vienna, VA 22184
(800) 332-4949
www.nwf.org

Pheasants Forever *
1783 Buerkle Circle
St. Paul, MN 55110
(651) 773-2000
www.pheasantsforever.org

Quail Unlimited *
31 Quail Run, P.O. Box 610
Edgefield, SC 29824
(803) 637-5731
www.qu.org

Rocky Mountain Elk Foundation *
2291 W Broadway, P.O. Box 8249
Missoula, MT 59807
(406) 523-4500
www.rmef.org

Society for Range Management
445 Union Blvd., Suite 230
Lakewood, CO 80228
(303) 986-3309
www.rangelands.org

National Fish and Wildlife-Oriented Partner Organizations

(* indicates National MOU with NRCS, ** indicates National MOU with NRCS in development)

The Nature Conservancy *
4245 North Fairfax Drive, Suite 100
Arlington, VA 22203-1606
(800) 628-6860
www.nature.org

The Wildlife Society *
5410 Grosvenor Lane
Bethesda, MD 20814
(301) 897-9770
www.wildlife.org

Trout Unlimited **
1500 Wilson Boulevard, Suite 310
Arlington, VA 22209-2404
(703) 522-0200
www.tu.org

Wildlife Habitat Council *
8737 Colesville Road, Suite 800
Silver Spring, MD 20910
(301) 588-8994
www.wildlifehc.org

Wildlife Management Institute *
1101 14th Street, NW, Suite 801
Washington, DC 20005
(202) 371-1808
www.wildlifemanagementinstitute.org

Quality Deer Management Association
P.O. Box 227
Watkinsville, GA 30677
(800) 209-3337
www.qdma.com

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Regional Fish and Wildlife-Oriented Partner Organizations

Point Reyes Bird Observatory
4990 Shoreling Highway
Stinton Beach, CA 94970
(415) 868-1221
www.prbo.org

Rocky Mountain Bird Observatory
14500 Lark Bunting Land
Brighton, CO 80603-9311
(303) 659-4348

Manomet Center for Conservation Sciences
81 Stage Road, P.O. Box 1770
Manomet, MA 02345
(508) 224-6521
www.manomet.org

California Waterfowl Association
4630 Northgate Blvd, Suite 150
Sacramento, CA 95834
(916) 645-1406
www.calwaterfowl.org

Alabama Waterfowl Association
1346 County Road #11
Scottsboro, AL 35768
(256) 259-2509
www.alabamawaterfowl.org

Minnesota Waterfowl Association
3750 Annapolis Lane, Suite 135
Plymouth, MN 55447
(763) 553-2977
www.mnwaterfowlassociation.org

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

National Biology Handbook

Subpart A—General Information

Part 602 Training Opportunities

United States
Department of
Agriculture

**Natural
Resource
Conservation
Service**

National Biology Handbook

Aquatic and Terrestrial Habitat Resources

Subpart B Conservation Planning

United States
Department of
Agriculture

**Natural
Resources
Conservation
Service**

National Biology Handbook
Subpart B—Conservation Planning

Part 610 Ecological Principles for Resource Planners

(190-VI-NBH, November 2004)

Part 610 Ecological Principles for Resource Planners

Contents:

610.00	**Ecosystems and landscapes**	**610–1**
610.01	**Ecosystem processes**	**610–2**
	(a) Energy flow	610–2
	(b) Water and nutrient cycles	610–3
610.02	**Ecosystem structure and its relation to ecosystem function**	**610–6**
610.03	**Ecosystem changes and disturbance**	**610–7**
	(a) Stability in ecosystems	610–7
610.04	**Biological diversity**	**610–8**
	(a) Hierarchy of diversity	610–8
	(b) Species interactions	610–10
610.05	**Applying ecological principles to habitat conservation, restoration, and management**	**610–11**
	(a) Area of management actions	610–11
	(b) Edge effects	610–11
	(c) Disturbance effects	610–11
	(d) Isolation and distance effects	610–12
	(e) Habitat heterogeneity	610–12
610.06	**Literature Cited**	**610–12**
610.07	**Glossary**	**610–13**

Table	**Table 610–1** Indicators of biodiversity at four levels of organization	610–9

Figures

Figure 610–1	Ecological principles for land management planners	610–1
Figure 610–2	Aquatic food web	610–2
Figure 610–3	Terrestrial food chain	610–3
Figure 610–4	Hydrologic cycle	610–4
Figure 610–5	Carbon cycle and its effect on the Earth's atmosphere	610–5
Figure 610–6	Nitrogen cycle	610–5
Figure 610–7	Nitrogen pathways on working lands	610–6
Figure 610–8	Landscape elements: patch, matrix, and corridor	610–6
Figure 610–9	Flood pulse concept	610–7
Figure 610–10	Rock and timber revetment on the Willamette River, Oregon	610–7
Figure 610–11	Black-tailed prairie dog	610–10

Cover photos courtesy of Wendell Gilgert, Tim McCabe, Charlie Rewa, and Gary Wilson, USDA NRCS, and the Utah Division of Wildlife Resources.

610.00 Ecosystems and landscapes

An *ecosystem* is a biological community, or assemblage of living things, and its physical and chemical environment. The interactions among the biotic and abiotic components of ecosystems are intricate. Conservation of natural resources can be daunting when the social, cultural, economic, and political realities of our modern world and the complex, multidimensional nature of ecosystems are considered.

Often fish, wildlife, and plants are dependent upon several ecosystems within broader landscapes. For example, migratory birds, butterflies, and salmon use different ecosystems that traverse political boundaries (often thousands of miles apart) during phases of their life cycles. Conservation of these migratory species creates land management challenges that can only be adequately addressed at the landscape scale. *Landscape ecology* considers principles about the structure, function, and changes of interacting ecosystems in natural resource conservation and planning (Forman and Godron 1986).

Dynamic processes occurring over multiple scales of time and space determine the physical and biological characteristics of our landscapes. These include:

- Geomorphological processes, such as erosion
- Natural disturbances, such as fires, floods, and drought
- Human perturbations, such as land clearing and urban development
- Changes in the make-up of biological communities, from days to millions of years

To implement effective conservation practices that take into consideration the often-extensive migratory paths of species, think broader than the project site and longer than the project time (fig. 610–1). Even a cursory evaluation of landscape conditions and their ecological and cultural history provides a valuable context when considering fish and wildlife resource concerns. This can lead to a better understanding of how large-scale processes affect individual parcels of land and the habitats they provide, and how actions on small pieces of land can influence ecological processes and biodiversity at broader scales.

Figure 610–1 Ecological principles for land management planners (from Dale et al. 2001)

Time	Ecological processes function at many timescales, and ecosystems change through time.
Species	Individual species and assemblages of interacting species have key, broad-scale ecosystem effects.
Place	Local conditions (climate, geomorphology, soil quality, altitude) as well as biological interactions affect ecological processes and the abundance and distribution of species.
Disturbance	The type, intensity, and duration of disturbances shape the characteristics of populations, communities, and ecosystems.
Landscape	The size, shape, and spatial relationships of land cover types influence the dynamics of populations, communities, and ecosystems

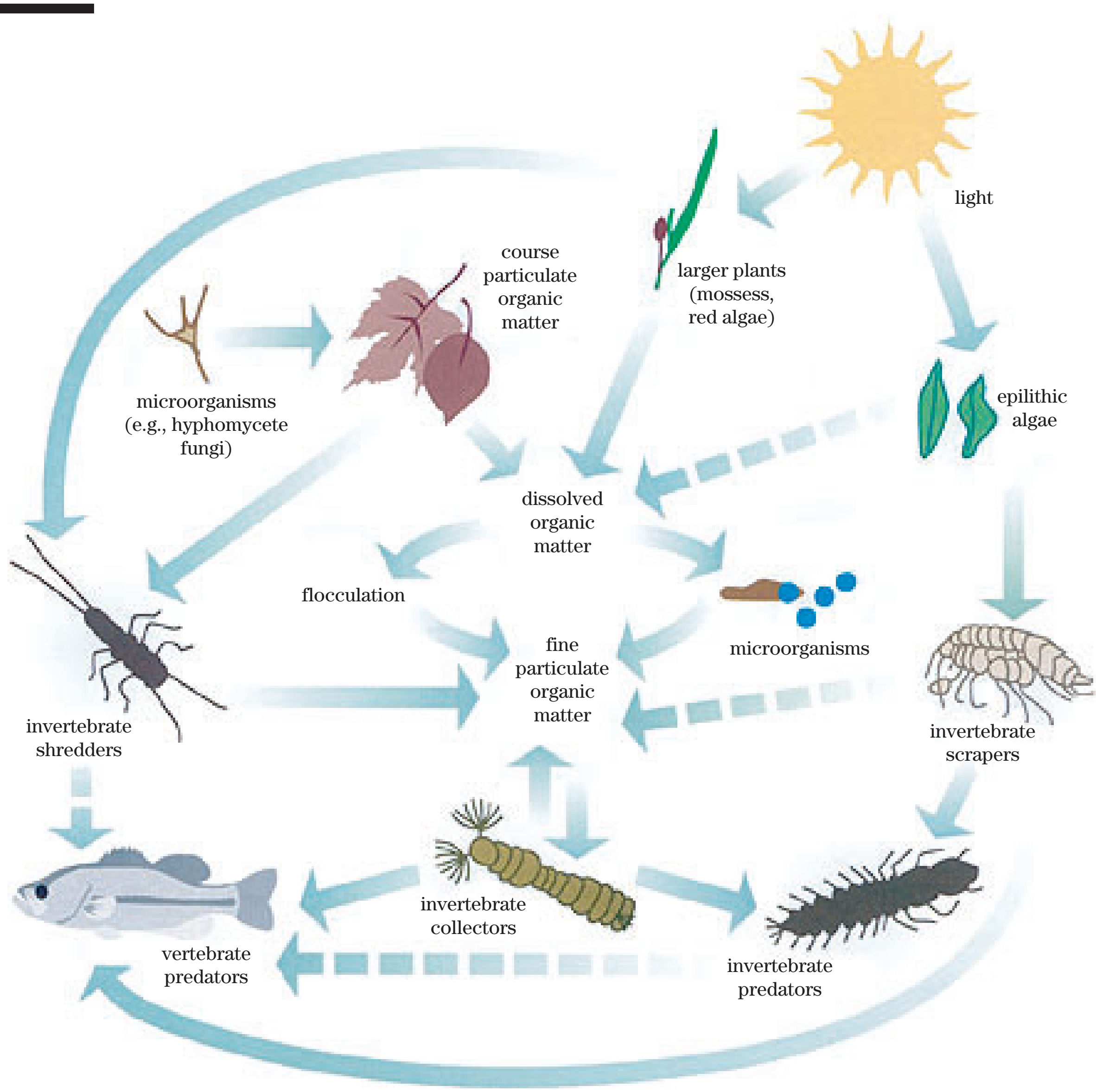
610.01 Ecosystem processes

(a) Energy flow

Energy flows through and fuels ecosystems and all living things. Virtually all energy originates from the sun. Organisms can be grouped into food chains, or more complex food webs, according to the trophic level that represents where they obtain energy from their environment as shown in figures 610–2 and 610–3. From a habitat management standpoint, the sources of available energy at each trophic level affect the mix of species in an ecosystem, their populations, and how they interact.

Green plants are *autotrophs*, or primary producers. They use solar energy for photosynthesis, combining atmospheric carbon dioxide and water into high-energy carbohydrates, such as sugars, starches, and cellulose (see section (c) Carbon cycle).

Figure 610–2 Aquatic food web (from Stream Corridor Restoration: Principles, Processes, and Practices)

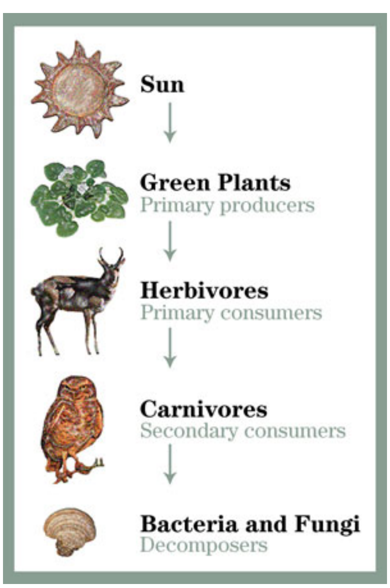


Animals are *heterotrophs;* they derive their energy from the carbohydrates stored within plants. Heterotrophs can be herbivores or carnivores. Herbivores, or primary consumers, obtain their energy by directly consuming plants. Carnivores, or secondary consumers, derive their energy by consuming herbivores and other carnivores. Animals that eat both plants and other animals are referred to as omnivores. Food chains or webs end with decomposers, usually bacteria and fungi, that recycle nutrients from dead or dying plants and animals of higher trophic levels.

The amount of energy available to organisms at different trophic levels declines as it moves through an ecosystem. Thus, more energy is available to support plants than herbivores and even less to support carnivores. As a rule of thumb, only about 10 percent of the energy that flows into a trophic level is available for use by species in the next higher level.

For example, if green plants are able to convert 10,000 units of energy from the sun, only about 1,000 units are available to support herbivores and only about 100 to support carnivores. Energy is lost primarily in the form of heat along the food chain.

Figure 610–3 Terrestrial food chain



(b) Water and nutrient cycles

Water and elements, such as carbon, nitrogen, and phosphorus, are critical to life. Unlike energy that flows through an ecosystem, these materials are cycled and reused repeatedly. In river systems, nutrients are said to spiral rather than cycle as they do on land.

Nutrient spiraling is a concept that explains the directional transport of nutrients in streams and rivers, rather than closed *nutrient cycles* associated with terrestrial ecosystems. All of these important processes provide elements that are essential to all living things, and all are powered by energy. Thus, human actions that disrupt or alter energy flow in ecosystems also affect water and nutrient dynamics in those systems.

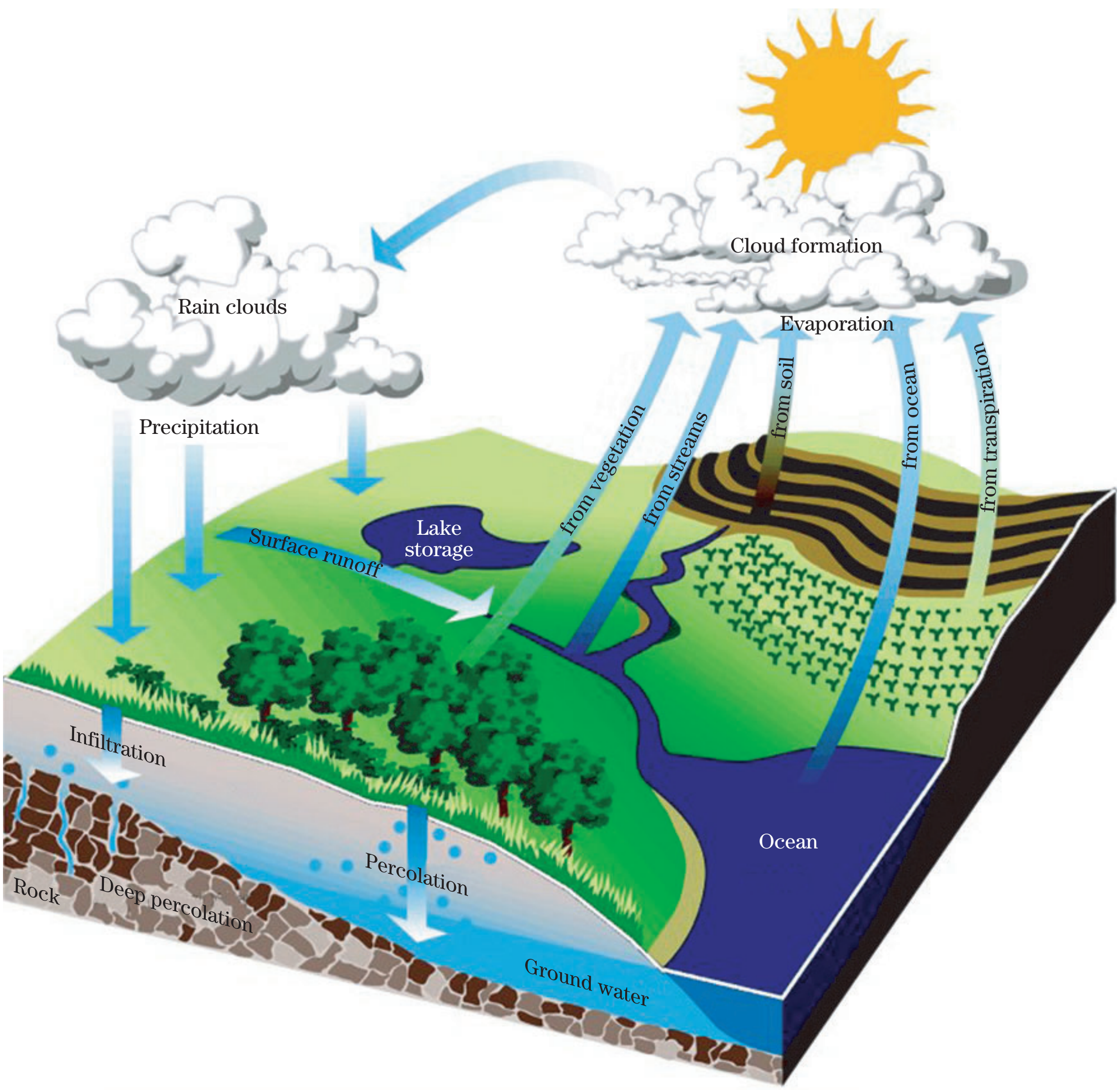
The water, or hydrologic cycle (fig. 610–4), has two phases: the uphill phase driven by solar energy, and the downhill phase, which supports ecosystems.

Most rainfall comes from water evaporated from the sea by solar energy (uphill phase). In fact, about a third of the solar energy reaching the Earth's surface is dissipated in driving the hydrologic cycle.

Approximately 80 percent of rainfall recharges surface and groundwater reservoirs and only 20 percent returns directly to the sea. As water moves through ecosystems (downhill phase), it shapes the physical structure of the landscape through erosion and deposition. It also affects the distribution and abundance of living things as it regulates availability of nutrients in soil that must be dissolved by water to be utilized by plants. Soil is thus an essential component in the water cycle.

The water cycle links the land to aquatic ecosystems where the flow rate and nutrient levels determine the make-up of their biological communities. Carbon dioxide (CO_2) in the Earth's atmosphere, and that which is dissolved in water, serves as the reservoir of inorganic carbon from which most carbon compounds used by living things are derived. During photosynthesis, plants use CO_2 to manufacture carbon compounds such as glucose and lignin, thus beginning the *carbon cycle*.

Figure 610–4 Hydrologic cycle (from Stream Corridor Restoration—Principles, Processes, and Practices)



During plant respiration, some CO_2 is released back into the atmosphere, but much is stored, or sequestered, in both live and dead plant tissues (fig. 610–5). The majority of climate researchers believe that human activities, including the burning of fossil fuels and clearing of forests, have increased the amount of CO_2 in the atmosphere (Houghton et al. 2001). A greenhouse effect results as CO_2 increases the amount of heat trapped in the atmosphere.

One of the most biologically important elements for living things is nitrogen, which constitutes about 78 percent of Earth's atmosphere as nitrogen gas (N_2). Although important, nitrogen gas is virtually unusable by all but a few living things.

The *nitrogen cycle* (fig. 610–6) is dependent on bacteria and algae in soil and water capable of using atmospheric nitrogen to synthesize or fix nitrogen. The resulting nitrogen-containing compounds can then be used by higher plants and animals. Some legumes and other plants fix nitrogen through bacteria that live in specialized nodules on their roots. Nitrogen stored in plants is available to plant-eating heterotrophs. As animals die or are consumed by other organisms, the nitrogen eventually enters the soil where denitrification returns it to the atmosphere (fig. 610–7).

Figure 610–6 Nitrogen cycle

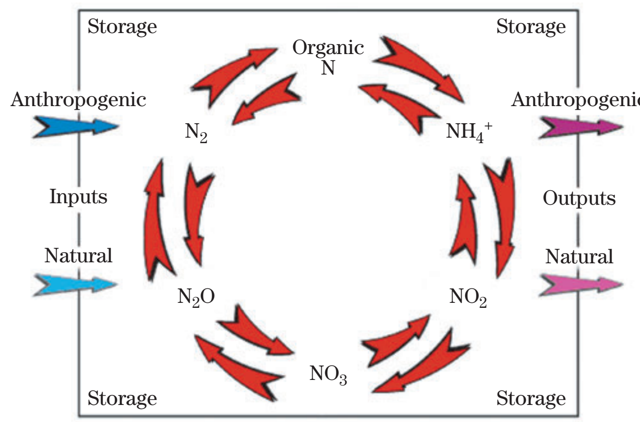
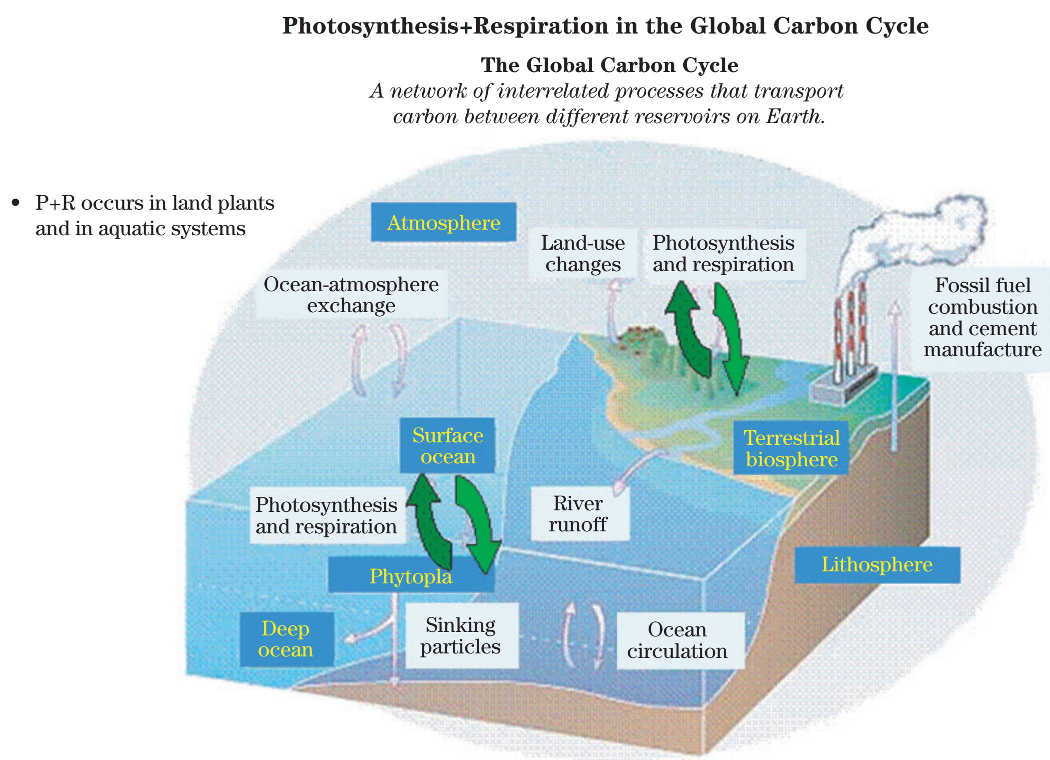
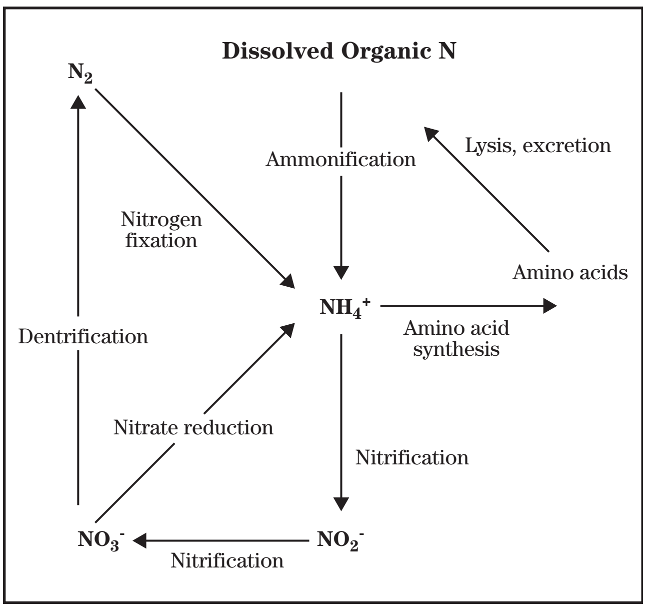


Figure 610–5 Carbon cycle and its effect on the Earth's atmosphere



In the *phosphorus cycle*, plants and bacteria take up phosphorus from soil. Phosphorus is required for energy transformations within the cells of organisms. Animals obtain it from plants and other animals. Phosphorus returns to an ecosystem's reservoir through excretion and decomposing organic tissue of both plants and animals.

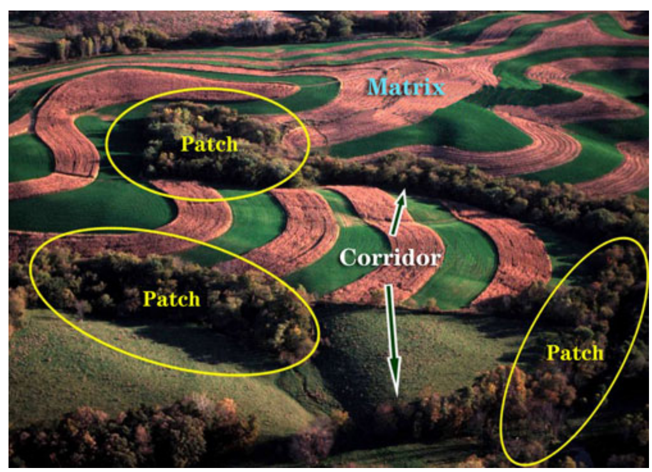
Figure 610–7 Nitrogen pathways on working lands



610.02 Ecosystem structure and its relation to ecosystem function

The physical structure of ecosystems varies according to climatic patterns, soil types, soil qualities, disturbance patterns, geologic events, biological interactions, and human perturbations. Individual ecosystems of a landscape can be thought of as patches or corridors within a matrix where flow of energy, materials, and species occurs (fig. 610–8). The components of ecosystems, such as animals, plants, biomass, heat energy, water, and mineral nutrients, are heterogeneously distributed among patches or corridors that vary in size, shape, number, type, and configuration.

Figure 610–8 Landscape elements: patch, matrix, and corridor (photo courtesy Iowa NRCS)



610.03 Ecosystem changes and disturbance

(a) Stability in ecosystems

Many of the familiar ecosystems have changed dramatically over the last 10,000 years. For example, following the last glacial period, North America became more arid and deserts now occupy areas that were once coniferous forests. Ecosystems and their processes may appear static because the frame-of-reference is typically limited to the perspective of a human life span.

In reality, ecosystems are in a constant state of flux. The stability and health of ecosystems are human concerns. This stability is measured by the resilience to natural disturbances or human perturbations. Natural disturbances, although temporarily disruptive, are important for maintaining many ecosystem processes and thus biological communities. They can also wreak havoc on infrastructure and human economies. On the other hand, human-induced perturbations that cause a departure from normal ecosystem processes may disrupt ecosystem sustainability and the associated production of goods and services.

Natural disturbances, such as fire, floods, hurricanes, and tornadoes, all affect and change ecosystems. They may significantly alter the existing community of plants and animals, making conditions favorable to other species, including alien invasive species. The community progresses through a series of overlapping, successive steps that provide habitat for different species. Over time, succession may lead back to an ecosystem similar to the original. However, if there have been climatic changes or new species have moved into the area, the biological community may be significantly different. Fire is one of the most important natural disturbances because of its high frequency and the extent of area it affects. Where fire is frequent, plants and animals have adapted to it. In fact, the seeds of many plant species lie dormant in the soil waiting for a fire event to release nutrients and provide sunlight that was once blocked by the previous canopy of vegetation. Fire and other natural disturbances create a diversity of habitats within the landscape.

In river and stream ecosystems, recurring floods are critical to sustained production of fisheries, flood plain forests, wetlands, and riparian habitat. Rivers and streams derive most of their biomass from within the flood plain and their biological communities are dependent on lateral exchanges of water, sediment, and nutrients among the flood plain, the riparian area, and river channel (fig. 610–9).

Aquatic species move into the flood plain at rising and high water levels because of feeding and spawning opportunities; terrestrial animals along the rivers then exploit the available food sources that result from receding water. Dams, dikes, and extensive revetments along rivers have significantly reduced the function of flooding in sustaining ecosystem processes in large rivers (fig. 610–10).

Figure 610–9 Flood pulse concept

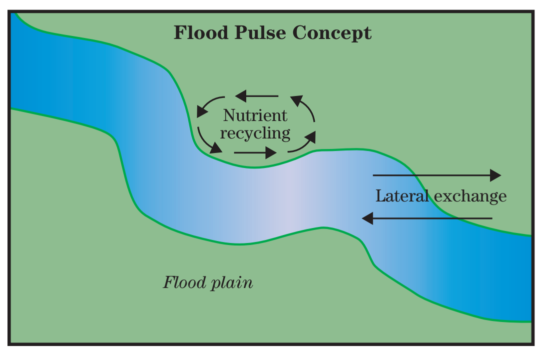


Figure 610–10 Rock and timber revetment on the Willamette River, Oregon (photo courtesy Kathryn Boyer, USDA NRCS)

Ecosystems are dynamic, and change is the normal course of events. Change in vegetation structure often creates a more diverse or heterogeneous array of habitats for terrestrial wildlife. Many past management decisions, such as fire suppression and flood prevention, have been undertaken to minimize the dynamic nature of some ecosystem processes to protect and promote human interests. From a fish and wildlife standpoint, this has tended to simplify habitats, disconnect the flow of nutrients, and isolate populations.

610.04 Biological diversity

(a) Hierarchy of diversity

Biological diversity or *biodiversity* is the variety and variability among living organisms and the ecological complexes in which they occur.

Biodiversity is organized hierarchically, beginning with the genetic diversity of individual organisms and ending with the diversity of ecosystems available in landscapes (Noss 1990) (table 610–1). It includes the full range of species, from viruses to plants and animals, the genetic diversity within a species, and the diversity of ecosystems in which a community of species exists. Land management goals that include conservation of biodiversity require that decisions be made over spatial scales that are much larger than individual parcels of land.

A *species* is a group of individuals that are morphologically, physiologically, or biochemically distinct. In addition, they have the potential to breed among themselves and do not normally breed with individuals of other groups. Species that range over wide geographical areas often are divided into *subspecies* if their morphological characteristics vary enough to make them distinctive.

A *population* is a group of individuals of the same species that share a common gene pool. This means they are in close enough proximity to each other to potentially interbreed, although they often do not. Populations of many species have wide distributions and to a greater or lesser extent are geographically isolated from each other by physical barriers or distance. A population of frogs in a small pond is isolated from a population of frogs in another pond many miles away. The probability that the two populations will interbreed is low.

A *metapopulation* is the collective group of discrete populations of a species across a landscape upon which the species' continued existence depends. For example, a natural disturbance, such as fire, may cause local extermination of an amphibian species population. The existence of other populations in a

Table 610–1 Indicators of biodiversity at four levels of organization (Noss 1990)

Organizational level	Compositional factors	Structural indicators	Functional indicators
Regional landscape	Identity, distribution, richness, and proportions of patch (habitat) types, collective patterns of species distributions (richness, endemism)	Heterogeneity, connectivity, spatial linkage, patchiness, porosity, degree of fragmentation, juxtaposition, perimeter-area ratio, pattern of habitat layer distribution	Disturbance processes, nutrient cycling rates, energy flow rates, patch persistence and turnover rates, rates of erosion and deposition, human land-use trends
Community ecosystem	Identity, relative abundance, frequency, richness, evenness, and diversity of species and guilds; proportions of endemic, exotic, threatened, and endangered species	Substrate and soil variables, slope and aspect, vegetation biomass and physiognomy, foliage density and layering, horizontal patchiness, canopy openness and gap proportions, abundance, density, and distribution of key physical features, water and resource availability	Biomass and resource productivity, herbivory, parasitism, predation rates, colonization and local extinction rates, patch dynamics (fine-scale disturbance processes), nutrient cycling rates, human intrusion rates and intensities
Population species	Absolute or relative abundance, frequency, importance or cover value, biomass, density	Dispersion, population structure (sex ratio, age ratio), habitat variables (see community-eco-system structure, above)	Demographic processes (fecundity, recruitment rate, survivorship, mortality), metapopulation dynamics, population genetics (see below), population fluctuations, physiology, life history, growth rate (of individuals), adaptation
Genetic	Allelic diversity, presence of particular rare alleles, deleterious recessives, or karyotypic variants	Effective population size, heterozygosity, chromosomal or phenotypic polymorphism, generation overlap, heritability	Inbreeding depression, outbreeding rate, rate of genetic drift, gene flow, mutation rate, selection intensity

landscape that allows their dispersal increases the chances that the species will eventually recolonize the burned area as it recovers.

Genetic diversity among individuals of a population allows for greater flexibility of a species to adapt to changing environmental conditions. For example, genes of one population may offer resistance to a disease that members of another population do not have. If the disease eliminated the other population(s), the resistant group serves as a source for reestablishment of populations in other areas.

Some populations may go extinct on a local scale, and new populations may become established on nearby suitable sites. The close proximity of another population of the same species allows colonization of a disturbed site following natural disturbance or human perturbation. For example, draining and converting a wetland basin to agriculture results in loss of wetland-associated species from the site. However, where wetlands are restored, dispersal of plant seeds and emigration of animals from nearby wetlands provide a ready means of recolonization.

A *biological community* is an assemblage of populations of many species. Within the biological community each species uses resources that constitute its niche. For example, a niche for a bird includes where it nests, what it feeds on, how it obtains water, where it migrates, and even its daily time of activity.

When managing for a single species, it is important to understand its role in the biological community and how it interacts with the assemblage of other species that are part of its ecosystem. Community composition is often affected by predator-prey interactions and competition among species. Predators can dramatically reduce the numbers of herbivore species. This alters the trophic structure of the entire community. Reduction in one herbivore species lessens consumption of specific plants within the community and may allow another species to use the resource and increase its population size.

Predators can also increase the biological diversity and individual species numbers of an area. For example, coyotes control mid-size predators, such as foxes and cats that prey on songbird populations. A reduction in foxes and cats allows songbird numbers and diversity to increase.

(b) Species interactions

Within biological communities, thousands of organism species interact. Some species may be considered more valuable because their presence is critical to the ability of other species to persist in the community.

Keystone species are those that have an ecological function on which other species and components of the ecosystem depend. The black-tailed prairie dog (fig. 610–11) is an example of an organism considered by many to be a keystone species of the shortgrass prairie ecosystem.

Indicator species are species whose presence indicates a particular state or condition of an ecosystem. For example, stream conditions are often assessed by monitoring the presence of aquatic insects, such as mayflies, stoneflies, and caddisflies. In stream ecosystems these species serve as indicators of water quality and good coldwater habitat.

Figure 610–11 Black-tailed prairie dog (photo courtesy US FWS)

610.05 Applying ecological principles to habitat conservation, restoration, and management

The loss and fragmentation of natural habitats have reduced biological diversity and resulted in considerable loss of fish and wildlife resources important to society. Land use changes are not the only culprit, however. Another factor affecting the loss of biological diversity and decline of species important to ecosystems is the introduction or invasion of alien species.

Nearly half of the imperiled species in the United States may be threatened directly or indirectly by alien species (Wilcove et al. 1998). Considering these threats, the following topics are important issues when working with fish and wildlife habitat and should be considered during planning activities.

(a) Area of management actions

The number of individuals and species an area can support is related to its size and the life histories and dynamics of the biotic community it supports. In some ecosystems, such as grasslands, areas smaller than 250 acres may not be able to withstand significant perturbations without the loss of many species of vertebrate animals and plants (Crooks and Soule 1999).

Small areas of habitat are usually insufficient to support larger species. Therefore, conservation and restoration efforts should consider project size and connectivity potential to the extent possible. In addition, efforts should be made to work with adjacent landowners to build contiguous blocks of habitat and link isolated patches of both terrestrial and aquatic habitats.

(b) Edge effects

The ratio of edge to habitat interior increases geometrically as fragment size decreases. Edge occurs when habitat meets a road, crop field, land use change, or other feature, such as a stream. Wildlife management has historically focused on creating edge habitat for the benefit of specific species. However, increased edge can adversely affect many species. These adverse effects are:

- Greater rates of habitat desiccation and loss of native vegetation
- Greater frequency and increased severity of fire
- Greater rates of predation by native and exotic predators (e.g., house cats, foxes, crows, blue jays)
- Higher probability of nest parasitism
- Greater windfall damage
- Greater intensities of browsing, grazing, and other forms of disturbance that favor the growth and spread of weedy and alien invasive species, both plants and animals (Wilcove et al. 1986, Noss and Cooperrider 1994)

Roads are the most frequent source of new edge and may facilitate the movement of weeds and pests. They also cause erosion, stream sedimentation, pollution, and increases in mortality rates of wildlife from collisions (Noss 1992). Especially in situations where area-sensitive species needs are considered, habitat conservation, restoration, and management efforts should reduce edge and minimize roads to the greatest extent possible.

(c) Disturbance effects

Natural disturbances, such as fire, storms, floods, and disease outbreaks, can increase the mosaic of habitat and increase biological diversity within a large habitat area. They can also overwhelm small habitat patches. Small areas are more likely to burn completely, resulting in loss or degradation of the community. These factors require careful management and control of disturbance in smaller habitat patches.

(d) Isolation and distance effects

Fragmentation is the alteration of natural patterns of landscapes or ecosystems, creating smaller patches or disrupting the continuity or connectivity of corridors and networks. As habitat patches become isolated and the distance between patches increases, it is harder for many species to disperse and migrate between them. Life cycles of the organisms that make up a biological community are dependent upon the ability of the organism to safely disperse or migrate. Lower dispersal and migration rates increase the likelihood a species will be extirpated from the area, and possibly become threatened or endangered in the long term.

Habitat conservation should focus on maintaining habitat connectivity and linking isolated patches. Maintaining connections on land and in streams and rivers is critical to the long-term survival of fish, wildlife, and all of the ecological components on which they depend.

(e) Habitat heterogeneity

Heterogeneity is the complexity or variation in physical structure of habitats. For example, in streams, water depth, velocity, substrate, wood, and pool/riffle complexes add to the heterogeneity of the habitat. Increased heterogeneity creates a variation in habitats for terrestrial and aquatic organisms and supports a greater diversity of species. It also provides more flexibility for species as they seek different types of habitats during different stages of their life cycles.

The complexity of interactions within and among species in ecosystems often defies our capacity to understand how to effectively manage natural resources. Actions and practices that maintain habitat and nutrient linkages, allow dispersal and migration, and sustain the processes that support the biological community as a whole are likely to be more effective at enhancing habitat for all dependent species, including those featured in specific management objectives.

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610.07 Glossary

Anthropogenic—Caused by humans.

Autotrophs—Primary producers, such as green plants, that use solar energy for photosynthesis, combining atmospheric carbon dioxide and water into high-energy carbohydrates, such as sugars, starches, and cellulose.

Biological diversity (biodiversity)—Variety and variability among living organisms and the communities, ecosystems, and landscapes in which they occur.

Community—An assemblage of populations of many species living and interacting in close proximity to each other.

Decomposers—Organisms, such as bacteria and fungi, that are found at the bottom of the food chain. They recycle nutrients from dead or dying plants and animals of higher trophic levels.

Ecosystem—A conceptual unit of living organisms and all the environmental factors that affect them; a biological community or assemblage of living things, and its physical and chemical environment.

Genetic diversity—Array of different genes available in a population's gene pool. Genetic diversity is needed among individuals of a population to allow for greater flexibility of a species to adapt to changing environmental conditions.

Heterogeneity—Complexity or variation in physical structure of a habitat.

Heterogeneous habitat—Diverse or consisting of many different structural components, substrates, types of vegetation, climates, etc.

Heterotrophs—Animals that derive their energy from the carbohydrates stored within plants. Heteroptrophs can be herbivores or carnivores.

Indicator species—Those species whose presence indicate a particular state or condition of an ecosystem.

Keystone species—Species that have an ecological function on which other species and components of an ecosystem depend.

Landscape—(1) An area of land consisting of a number of ecosystems; (2) A heterogeneous land area consisting of three fundamental elements: patches, corridors, and a matrix. A *patch* is generally a plant and animal community that is surrounded by areas with different community structure. A *corridor* is a linear patch that differs from its surroundings. A *matrix* is the background within which patches and corridors exist and which defines the flow of energy, matter, and organisms.

Landscape ecology—Study of the spatial and temporal relationships of interacting ecosystems, especially their structure, function, and ecological processes.

Natural disturbance—Any relatively discrete event in nature that disrupts ecosystem, community, or population structure and changes resources, habitat availability, or the physical environment. Natural disturbances include floods, wildfire, earthquakes, volcanic eruptions, tornadoes, hurricanes, and tidal waves.

Metapopulations—Collective group of discrete populations of a species across a landscape upon which the species' continued existence depends.

Niche—All of an organism's interactions with its environment.

Nutrient spiraling—Directional transport of nutrients in streams and rivers, rather than closed nutrient cycles associated with terrestrial ecosystems.

Omnivores—Animals that eat both plants and other animals.

Perturbations—A departure from the normal state, behavior, or trajectory of an ecosystem; alteration of ecosystem processes as a result of human actions, such as land use. Examples of perturbations include disruption of natural flow regimes with dam construction or changes in groundwater hydrology caused by poor livestock management or wetland drainage.

Population—A group of individuals of the same species that share a common gene pool. They are close enough to each other to potentially interbreed, although they often do not.

Primary consumers—Organisms that eat green plants, or herbivores.

Secondary consumers—Organisms that eat herbivores, or carnivores.

Species—A group of individuals that are morphologically, physiologically, or biochemically distinct.

Subspecies—Division of species into subcategories that best describe the relationships of their morphological characteristics.

Trophic level—An organism's position in a food chain or food web.

United States
Department of
Agriculture

**Natural
Resources
Conservation
Service**

National Biology Handbook
Subpart B—Conservation Planning

Part 611 Conservation Planning for Integrating Biological Resources

(190-VI-NBH, November 2004)

Part 611

Conservation Planning for Integrating Biological Resources

Contents:

611.00	**Integrating fish and wildlife into cooperator's objectives**	**611–1**
611.01	**Fish and wildlife/biological resources: different meanings for different people**	**611–2**
611.02	**Planning to meet life history needs of fish and wildlife**	**611–3**
	(a) Water	611–3
	(b) Food	611–3
	(c) Space	611–3
611.03	**National conservation practice standards specific to fish and wildlife resources**	**611–4**
611.04	**Elements of the planning process**	**611–8**
611.05	**Summary**	**611–12**

Table

Table 611–1	Biological groupings and relevant conservation practices	611–5

Figures

Figure 611–1	Fish and wildlife require water, food, and space	611–3
Figure 611–2	A landowner and NRCS conservationist discuss plantings that provide wildlife food and cover	611–3
Figure 611–3	This fishway was funded in part by the NRCS-WHIP program to provide passage to spawning habitat for migratory fish	611–10

Cover photos courtesy Wendell Gilgert, Gary Kramer, and Dot Paul, USDA Natural Resources Conservation Service, and Jeff Rodgers, Oregon Department of Fish and Wildlife

611.00 Integrating fish and wildlife into cooperator's objectives

The point when a conservation planner generally establishes an effective relationship with a cooperator starts when the cooperator (used interchangeably with landowner, land manager, producer, farmer, or rancher) makes a phone call to a USDA Service Center, walks into an NRCS field office, or follows a referral from the Farm Services Agency, RC&D coordinator, or the Soil and Water Conservation District. Often this contact is made because the cooperator has a concern or a problem that requires technical assistance with resource concerns on a piece of working land.

During the introductory stages of the relationship with the cooperator, the planner begins to assess the situation in the area where the resource concern exists. Like anything new, there is a level of excitement as the process begins of working with the cooperator to develop the conservation plan, assist with the implementation of the plan, then continue to support the assessment and monitoring of the effectiveness of the conservation activities.

Hugh Hammond Bennett, the first Chief of the Soil Conservation Service, in his text, *Elements of Soil Conservation*, stated that "*consideration of the land's relationship to the entire farm, ranch, or watershed*" is the key principle of conservation planning. While the planner is comfortable with his or her general knowledge of most of the natural resources encountered on the cooperator's land, he or she is not likely to be equally knowledgeable about all of the planning elements—soil, water, air, plants, and animals (SWAPA)—that occur on the land.

The purpose of this handbook is to assist the planner who does not have extensive knowledge or experience with fish and wildlife resources, or *biological resources*, to more effectively integrate considerations of these resources into the development and implementation of the conservation plan.

Hugh Hammond Bennett's vision of natural resource planning included some key attributes of conservationists who are effective planners.

An effective planner

- ***Considers the needs and the capability of each acre***. Conservation planning is not an overnight process. It is an accumulation of knowledge, skills, and abilities acquired relative to natural resources. It requires an understanding of soil surveys, ability to read maps, and ability to understand human history of the area. The ability to read the landscape is needed. Many landscapes in North America are in some need of restoration. In other words, they have been used hard, but they could flourish and become more sustainable than they are under current land use regimes.

- ***Is cognizant of the cooperator's situation***. An effective planner understands the consequences of proposed actions and helps the cooperator clearly understand his or her impact on and off the parcel of land for which they are concerned. The cooperator has economic, social, political, and cultural constraints. The conservation planner needs to be aware of various cooperator issues.

- ***Incorporates the cooperator's aptitude to change***. Change is difficult for some, easy for others. Planners need to help people understand why a change in management may be needed for good conservation on the ground.

- ***Considers land surroundings and relationships***. An effective planner recognizes the interconnections between a site and the surrounding landscape. The adjacent property, subwatershed, river basin, watershed, state, and the region of the country should be considered. The planner must understand the land's location and its relationship to surrounding property. If a property is eroding severely, then not only is soil lost from that particular property, but water quality damage can occur in aquatic ecosystems downstream because of the sediment that originated on that piece of property. Water quality can also be used as a starting point for discussions related to integrated pest management (IPM) aimed at reducing pesticide use. Implementation of IPM may have significant wildlife ramifications when related to habitat and water quality enhancement.

Other considerations for an effective conservation planner:

- Respect the cooperator's rights and responsibilities.
- Recognize the need for resource sustainability. Keep current on new technology by reading scientific literature and attending resource conferences and workshops.
- Consider short-term, long-term, and cumulative effects of actions. Most of the landscapes did not degrade overnight. NRCS assistance is for the long term. Conservation is a process that takes time and care to get the land back to some level of sustainability and productivity.
- Consider economic needs and goals. What will it cost and how much time does the cooperator have to invest in the action?
- Work with cooperator to consider alternative enterprises and their interactions with the site and its surroundings.
- Help the cooperator develop and articulate the desired future conditions for the planning area. What would he or she like the property to look like? Encourage new ideas, provide relevant and timely information, and offer sound conservation advice.
- Collaborate with other natural resource professionals and volunteers when collecting, assembling, and evaluating data. Use resources and expertise of others. Interact and work with people who may have a different perspective about the resource concerns being considered.

611.01 Fish and wildlife/biological resources: different meanings for different people

A common vocabulary is important when discussing fish and wildlife or any biological resource with a cooperator. For many cooperators, the more familiar and visible fish and wildlife (e.g., white-tailed deer, mallards, black bass, raccoons, crows, rainbow trout, or prairie dogs) represent the significant biological resources on their land. A purpose of this handbook is to broaden how the planner, and thus the cooperator, thinks of the fish, wildlife, and biological communities that occur or could occur on a piece of working land. While conversions with the cooperator about the full range of biological resources on a particular property may not be possible, a general understanding of those resources by the planner can translate into an increased awareness of their values by the cooperator.

The most favorable time to incorporate biological resources into the plan discussion is during the initial conversations with the cooperator. As the planner probes the cooperator for information about their operation, it is always appropriate to ascertain the level of interest in their biological resources. Does the cooperator consider those resources to be part of the land’s production capability where an economic gain is realized? How does the cooperator feel about the presence or absence of those resources on the land? Are they seeing more or less fish and wildlife than they would like to see? Do fish and wildlife contribute to the quality of their experience of working and living on the land? Is the cooperator willing to adjust how they operate their enterprise or manage their land to accommodate biological resources?

While it is preferable to integrate biological resource needs into the early conversations with a cooperator, it is *never too late* to discuss those needs with a cooperator seeking technical assistance. An experienced planner, who has not fully discussed the inclusion of the biological resources of a planning area, should make an effort to do so at any time during the planning or implementation process. Remember, all lands and most landscape features provide habitat for biological resources, and the quality of that habitat varies.

611.02 Planning to meet life history needs of fish and wildlife

Most planners know that the basic life history requirements for fish and wildlife resources can be broadly grouped into three categories: water, food, and space (including cover and special habitat areas). When planning for an individual species or group of species, the planner must provide the cooperator with more specific information about life history needs. Always consider the specific biological needs for water, food, and space by fish and wildlife (fig. 611–1 and 611–2).

(a) Water

Some species, such as snakes, tortoises, desert mammals, and many insects, obtain all of their water requirements from the foods they eat. To support most wildlife, and obviously all fish species, a reliable free water supply is necessary. Virtually every type of uncontaminated surface water source is used by a variety of fish and wildlife species. A complete inventory of those sources should be a fundamental element to any conservation plan.

Figure 611–1 Fish and wildlife require water, food, and space (photos courtesy Wendell Gilgert, USDA NRCS)

(b) Food

Food habits for fish and wildlife are variable throughout the year. Feeding behavior and habits help broadly define groups of animals. Common examples are grazers (elk, prairie dogs, grasshoppers), browsers (deer, beaver), carnivores (snakes, hawks, bobcats), omnivores (black bears, coyotes, crows), and parasites (lampreys, many insects, cowbirds).

Food requirements vary with time of year. For specific information for any particular species, numerous technical references provide food habit information (see subpart C, part 620).

(c) Space

The space in which an organism lives provides protection, or cover. Cover types include structural elements in a species' habitat that provide a means of escape from danger (escape cover), provide refuge from temperature changes (thermal cover), protect young (nesting, fawning, or brood cover), provide resting areas (loafing or refugia cover), or helps the specie hide from predators (hiding cover). A space can also be a large area where several animals or biological resources come together for breeding (lekking, breeding, spawning areas), feeding, loafing, or staging for group migrations.

Figure 611–2 A landowner and NRCS conservationist discuss plantings that provide wildlife food and cover (photo courtesy Lynn Betts, USDA NRCS)

611.03 National conservation practice standards specific to fish and wildlife resources

Currently, the National Handbook of Conservation Practices lists more than 160 practices. Virtually every conservation practice impacts fish and wildlife resources. The following 16 practices are specifically related to fish and wildlife resources. These 16 practices will, if properly implemented and/or managed, positively affect biological resources; however, the challenge to the planner may be the integration of those resources into the other conservation practices.

Aquaculture Ponds (397)—A water impoundment constructed and managed for commercial aquaculture production. To provide suitable aquatic environment for producing, growing, and harvesting commercial aquaculture products.

Constructed Wetland (656)—A wetland constructed for the primary purpose of water quality improvement; i.e., treatment of wastewater, sewage, surface runoff, milk-house wastewater, silage leachate, and mine drainage. Practice treats wastewater by the biological and mechanical activities of the constructed wetland.

Early Successional Habitat Development/Management (647)—Manage early plant succession to benefit desired wildlife or natural communities. Increase plant community diversity, provide wildlife habitat for early successional species and provide habitat for declining species.

Field Border (386)—A strip of perennial grass or shrubs established at or around the edge of a field. Field borders provide productive habitat for wildlife that favor early successional habitats on agricultural landscapes.

Fish Passage (396)—Features to eliminate or mitigate natural or artificial barriers to fish movement, such as dams or cross-channel structures, to allow unimpeded movement for fish past stream barriers.

Fishpond Management (399)—Developing or improving impounded water to produce fish for domestic use or recreation. To provide suitable aquatic environment for producing, growing, and harvesting fish or other aquatic organisms for recreational or domestic uses.

Restoration and Management of Declining Habitats (643)—Restoring and conserving rare or declining native vegetated communities and associated wildlife species to restore and manage habitats degraded by human activity, increase native plant community diversity, or manage unique or declining native habitats.

Riparian Herbaceous Cover (390)—Consists of grasses, grass-like plants, and forbs at the fringe of the water along watercourses. Provides habitat for aquatic and terrestrial organisms, improves and protects water quality, stabilizes the channel bed and streambanks, establishes corridors to provide landscape linkages among existing habitats, and fosters management of existing riparian herbaceous habitat to improve or maintain desired plant communities.

Shallow Water Management for Wildlife (646)—Managing shallow water on agricultural lands and moist soil areas for wildlife habitat. Areas provide open water areas to facilitate waterfowl resting and feeding, and habitat for amphibians and reptiles that serve as important prey species for other wildlife.

Stream Habitat Improvement and Management (395)—Create, restore, maintain, or enhance physical, chemical, and biological functions of a stream system to provide desired quality and quantity of water, fish, and wildlife habitat, channel morphology and stability, and aesthetics and recreation opportunities.

Upland Wildlife Habitat Management (645)—Creating, restoring, maintaining, or enhancing areas for food, cover, and water for upland wildlife and species that use upland habitat for part of their life cycle. Provide all of the habitat elements in the proper amounts and distribution, and manage the species to achieve a viable wildlife population within the species home range.

Wetland Creation (658)—A wetland created on a site location that historically was not a wetland or was a wetland but with a different hydrology, vegetation type, or function than naturally occurred on the site. Create wetlands that have wetland hydrology, hydrophytic plant communities, hydric soil conditions, and wetland functions and/or values.

Wetland Enhancement (659)—The modification or rehabilitation of an existing or degraded wetland where specific function and/or values are improved for the purpose of meeting specific project objectives. For example, managing site hydrology for waterfowl or amphibian use, or managing plant community composition for native wetland hay production.

Wetland Restoration (657)—A rehabilitation of a degraded wetland where soils, hydrology, vegetative community, and biological habitat are returned to the original condition to the extent practicable. To restore wetland conditions and functions that occurred on the disturbed wetland site prior to modification to the extent practicable.

Wetland Wildlife Habitat Management (644)—Retaining, developing, or managing habitat for wetland wildlife. To maintain, develop, or improve habitat for waterfowl, furbearers, or other wetland-associated wildlife.

Wildlife Watering Facility (648)—Constructing, improving, or modifying watering facilities or places for wildlife to obtain drinking water.

Table 611–1 gives examples of broad fish and wildlife groupings and lists conservation practices that directly or indirectly impact the particular group.

Table 611–1 Biological groupings and relevant conservation practices

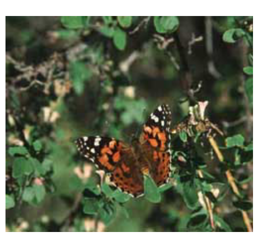
Biological group	Relevant practices
Invertebrates	
Aquatic—crayfish, snails, stoneflies, mayflies, riffle beetles (Photo courtesy Paul Fusco, USDA NRCS) 	Stream Habitat Improvement and Management (395), Riparian Forest Buffer (391A), Wetland Restoration (657)
Terrestrial *(Edaphic fauna)*—earthworms, nematodes, dung beetles	Conservation Cover (327), Forest Stand Improvement (666), Prescribed Grazing (528)
Pollinators—Integrating all types of flowering plants into vegetation enhances most areas for pollinators: bees, butterflies, moths, birds (Photo courtesy Gary Kramer, USDA NRCS) 	Alley Cropping (311), Conservation Crop Rotation (328), Tree/Shrub Establishment (612), Early Successional Habitat Development/Management (647)
Integrated pest management species—lady beetles, spiders, wasps	Pest Management (595), Residue Management, Mulch Till (329B), Riparian Herbaceous Cover (390)

Table 611–1 Biological groupings and relevant conservation practices—Continued

Biological group	Relevant practices
Vertebrates	
Fish: Cold-water—trout, salmon, grayling, whitefish Cool-water—pike, pickerel, walleye, suckers Warm-water—catfish, black bass, carp, bluegill, minnows	Nutrient Management (590), Irrigation Water Management (449), Riparian Forest Buffer (391), Stream Habitat Improvement and Management (395), Wetland Restoration (657), Fish Passage (396)
Amphibians—salamanders and newts, toads, frogs	Pond (378), Stream Habitat Improvement and Management (395), Wetland Restoration (657)
Reptiles—snakes, turtles, lizards, skinks	Wetland Wildlife Habitat Management (644), Wetland Restoration (657), Restoration and Management of Declining Habitats (643)
Birds: Songbirds (resident and neotropical migratory)	Early Successional Habitat Development/Management (647), Hedgerow Planting (422), Prescribed Burning (338)
Waterfowl—ducks, geese, swans (photo courtesy Wendell Gilgert, USDA NRCS) 	Wetland Wildlife Habitat Management (644), Shallow Water Management for Wildlife (646), Prescribed Grazing (528)
Shorebirds—sandpipers, plovers, stilts, avocets, dowitchers (photo courtesy Don Poggensee, USDA NRCS) 	Irrigation Water Management (449), Restoration and Management of Declining Habitats (643), Wetland Restoration (657)
Raptors—hawks, falcons, eagles, owls	Field Border (386), Residue Management, No-Till and Strip Till (329A), Windbreak/Shelterbelt Establishment (380)
Colonial nesting birds—egrets, herons	Wetland Restoration (657), Riparian Forest Buffer (391), Filter Strip (393)

Table 611–1 Biological groupings and relevant conservation practices—Continued

Biological group		Relevant practices
Game birds—grouse, quail, turkey, pheasants (photo courtesy Gary Kramer, USDA NRCS)		Forest Harvest Management (511), Field Border (386), Residue Management, No-Till and Strip Till (329A)
Mammals		
Large herbivores—elk, deer, pronghorn (photo courtesy Gary Kramer, USDA NRCS)		Brush Management (314), Prescribed Grazing (528), Wildlife Watering Facility (648), Fence (382)
Large predators—cougar, bear, wolf		Forest Stand Improvement (666), Riparian Forest Buffer (391), Tree/Shrub Establishment (612)
Mesopredators—raccoon, bobcat, skunk (photo courtesy Gary Kramer, USDA NRCS)		Conservation Cover (327), Stream Habitat Improvement and Management (395), Windbreak/Shelterbelt Establishment (380)
Small mammals—mice, beaver, prairie dogs		Early Successional Habitat Development and Management (647), Prescribed Grazing (528), Structure for Water Control (587)
Bats—resident and migratory		Mine Shaft & Adit Closing (457), Forest Harvest Management (511), Pond (378)

611.04 Elements of the planning process

Step 1 Identify problems and opportunities
Field office planners are required to consider soil, water, air, plants, and animals when developing a conservation plan. Concern for fish and wildlife resources is typically not the primary motivation for producers to contact NRCS conservationists for assistance. That fact should not prevent the conservationist from including fish and wildlife resources early in the process of identifying resource problems and opportunities. Explore as many aspects as the cooperator's interest and the conservationist's time allow.

Example: When a rancher contacts the conservationist with questions about grazing management, questions about native grazers should be interspersed into conversations that are intended to obtain information on livestock type, class, and herd size. Specifically, the conservationist should work with the rancher to answer these questions:

- What native grazers (e.g., rabbits, prairie dogs, elk) must rely on the same resources as domestic livestock?
- What are their life history requirements?
- How will those requirements be integrated into the grazing plan?

Subsequent conversations could include changing pasture size or configuration, which would involve discussion of fences, water, and salt or mineral distribution. With every element of the grazing plan, opportunities allow the planner to raise questions regarding the rancher's attitude toward and aptitude for the integration of fish and wildlife resources on the property. Does wildlife currently move freely on the ranch? If not, would the rancher be open to changing the fence configuration and wire placement to facilitate nonobstructed movement of deer, elk, moose, or pronghorn? Do the livestock stand in the stream, seep, or spring where they water? If so, could it be more efficient and improve herd health if the watering areas were fenced and the water piped into a storage tank for distribution to multiple troughs (with design provisions for wildlife access and egress)?

Step 2 Determine goals and objectives
A producer's motivation to initiate and work through the process of developing and then implementing a conservation plan can come from a concern and/or multiple concerns about the resources on their land or on lands affecting their operation. The step to assist the producer in determining the desired products of a plan may not be as simple as it sounds. It may take time to establish trust between the producer and the conservationist, which can entail many separate visits with the producer, especially if the conservation of the fish and wildlife resources was or is not a primary motivation for the conservation plan.

The planner can help the producer break down the conservation goals into three parts: productivity, quality of life, and the landscape. A discussion of production goals on their land is probably the most difficult and delicate topic of the three. A discussion of land, herd, or crop size with a producer is tantamount to a discussion of bank accounts or wills. Yet, unless the planner has a clear understanding of what the producer needs to produce, an honest conversation about the conservation elements that can be applied to the land is difficult. Armed with the productivity information, the planner can do a more complete job of formulating alternatives that can more fully integrate biological resources.

Example: A row crop and orchard producer in California was using up to 10 annual pesticide applications on his crops each year. Since more than 15 species of insect feeding bats are in his region, the planner suggested that the strategic placement of bat boxes could increase the local bat population to a level where crop insect pests could be controlled. Several years and bat boxes later, the producer's pesticide applications were reduced by more than two-thirds by the integrated pest management provided largely by the bats. This is an example of a previously unrecognized resource that enhanced habitat quality for the bats and other farm wildlife, improved water and soil quality on and off the farm, and reduced expensive inputs that allowed the producer more management flexibility.

The other elements of the overall plan goal are the quality of life and the landscape goal. Those goals are critical to understanding what motivates a producer to stay involved in a business that is often marginally productive. What is it that motivates the cooperator to face each day on the land? Is it the smell of newly swathed hay? Is it the sounds of resident or seasonal wildlife, the elk herd passing through on the way to winter or summer range? Is it the sound of the brook trout breaking water chasing a mayfly near the stream edge? Or is it the yearly proliferation of butterflies at the field's edge as they follow the nectar corridor? If it were entirely within the cooperator's ability, would the land have more trees, more open expanses, lush riparian areas, more songbirds, or more water?

Within the context of working with the cooperator to articulate his or her goals, the planner, through probing and timely questions, finds that the cooperator has or can have a much broader role for fish and wildlife resources on their land.

Step 3 Inventory resources

For the planner, the resource inventory is often one of the more eagerly anticipated steps of the planning process. During this process the planner is fully engaged with the cooperator to explore extensive information and gain an understanding of the cooperator's land and those lands that surround it. Numerous tools can assist the planner with this inventory. The following are considered essential for a thorough field inventory:

- Series of maps to locate the property in the proper landscape context
  - 71/2 minute quadrangle topographic map
  - aerial photos
  - soils maps
  - habitat maps
  - various layers of geographic information system (GIS) maps
- Camera
- Binoculars
- Notebook
- Field guides, soil survey
- Hand lens
- Safety kit
- Soil knife
- Daypack to keep materials in one location

Investigating and analyzing the resources gathered from the land can be as exhaustive as time allows. The planner must walk or ride with the cooperator to read the landscape, and should take legible notes their discussions. A comprehensive resource assessment may, therefore, require several visits to the property, which allows additional conservation opportunities with every trip. This, too, is an opportunity to locate specific and critical habitat elements for the fish and wildlife using the property. Water features are especially critical not only because of their relationship to biological resources, but because they are often indicators of wetland and cultural resource locations.

During the inventory process, it is critical to think beyond the property boundary in terms of both space and time. Some spatial scales that can be useful are the hemispheric, regional, watershed or subwatershed scale, and a field or tract level. A description of each follows.

Hemispheric scale—This scale is important for wildlife and fish that migrate long distances, such as salmon, waterfowl, neotropical migratory birds, bats, and various insects. Virtually all lands planned by NRCS conservationists are visited by transitory or migratory fish or wildlife at least once a year. Whether the animal spends a few days or an entire season on the cooperator's land, it is an important component for that species' overall life history and should be accommodated.

Regional scale—Steelhead, salmon, and other migratory fish; wide-ranging mammals including wolverines, jaguars, and elk; and many other species use a smaller, but critical, subset of a region in which the cooperator's land is located.

Watershed or subwatershed scale—Some species of fish and/or wildlife live their entire life cycles in discrete areas where cooperation and coordination among land managers are critical to their sustainability. These species include endemic species that are found only in a particular watershed or field office area. Also, local species are those that live their entire lives on individual farms or ranches. Typical examples include northern bobwhite, ring-neck pheasant, eastern cottontail, chickadees, titmice, and cardinals.

Field or tract level—This spatial scale is important for dispersal-sensitive species, such as frogs, chipmunks, native fish, or insects, that may never move past the boundary of a field or tract within a farm or ranch.

Time scales, or temporal scales, are also important considerations for fish and wildlife and their habitats. For example, the intervals of time between disturbance events, such as floods, fires, or hurricanes, affect species and their habitats. Some questions to ask:

- Is it a 2-year, 5-year, or 10-year flood that will most likely create the sediment point bar that will allow for a new generation of cottonwood seedlings to germinate in the riparian zone?
- Will a prescribed burn in brush cover cause a water release that will benefit the local amphibian population and at the same time favor early successional forbs for the migratory pollinators?
- How long will the effects last?

Step 4 Analyze resource data

The field office technical guide (FOTG) offers a template for organizing resource concerns. Many effective tools for analyzing data are available in the NRCS office or from wildlife agencies if you do not have appropriate wildlife habitat evaluation protocols readily available. The conservationist should work with State, Federal, or non-governmental fish and wildlife organizations to secure as much information as possible. Exhibit M in subpart C, part 630 is an example of a habitat evaluation from Utah. Every state has species habitat evaluations or habitat evaluations. In addition, the U.S. Fish and Wildlife Service has Habitat Suitability Index (HSI) models for many fish and wildlife species. The guides are relatively comprehensive and examine various aspects of habitat for a variety of fish and wildlife. Different habitat evaluation guides are available in each state or territory.

Step 5 Formulate alternatives

Develop alternatives that include a spectrum of conservation practices to use on the cooperator's land. These practices, when implemented, should achieve cooperator's objectives, solve identified problems, take advantage of opportunities, and prevent additional problems.

Achieve cooperator's objectives—Virtually all of the practices used to address the broad range of natural resource issues and concerns that producers encounter are in the FOTG and the nearly 160 conservation practices standards. Of these standards, only 16 are strictly fish and wildlife practices. Of the remaining practices, virtually all have the potential to address the needs of fish, wildlife, and other biological resources. For all practical purposes, every practice and management action taken on the land has some effect on biological resources. The conservationist's creativity, experience, education, and training can provide an opportunity to engage other people's expertise for incorporating fish and wildlife into the planning process. The planner must ensure that the natural resource conservation objectives of the cooperator are met. While working with the cooperator, conservation planners are uniquely positioned to inform them of the effects of various management alternatives on terrestrial and aquatic species and the opportunities to effectively integrate fish and wildlife objectives into the conservation planning process.

Solve identified problems—By now the problems that initiated development of the conservation plan in the first place should be clearly spelled out. During this step, the conservationist can explain how the resource problem more than likely began. The cooperator will begin to realize the consequences of various management actions on the land and the surrounding landscape. It is during this process of conservation planning and application that the planner can help the cooperator more fully understand stewardship obligations to the land.

Take advantage of opportunities—When it comes to economics, most cooperators are receptive to and qualify for cost-share programs or related assistance, such as grants, building materials, labor, or other resources needed to apply the necessary conservation practices (fig. 611–3). The planner needs to be aware

Figure 611–3 This fishway was funded in part by the NRCS-WHIP program to provide passage to spawning habitat for migratory fish (photo courtesy Paul Fusco, USDA NRCS)

of the array of technical and financial resources available to the cooperator. The cooperator may indicate a sincere desire to apply a conservation practice, but lack the resources to do so. At that point, the planner can offer cost-share programs, grants, and assistance from partner groups. The planner must facilitate development of partnerships (see subpart A, part 601, Conservation Partnerships) to help the cooperator take advantage of all available opportunities.

Prevent additional problems—Many tools are available to assist the planner with motivating the cooperator to think about alternative management or business practices that avoid generation of new natural resource management problems.

Example: A hay operator chooses to explore equipment modifications, such as a flush bar, to move nesting ducks, pheasants, or songbirds out of the swather or mover path so they are not destroyed during hay harvest activities. Perhaps harvest actions can be delayed for a couple of weeks to allow the nesting birds time to fledge their young and move out of the field. Think creatively and help the cooperator to think of ways to apply different cultural practices relating to agriculture, and, for example, the habits of migratory shorebirds. During the shorebird migration, the birds may be onsite for only a few days. In some cases the shorebirds may stay and nest. The cooperator can alter irrigation management practices by providing additional soil moisture or altering planting dates and can benefit these species by providing soil foraging resources through this process.

Step 6 Evaluate alternatives

The planner should provide sufficient information about each alternative or combination of alternatives so that the cooperator can make decisions that work towards the stated goals. Potential positive as well as negative outcomes should be discussed. Each step of conservation planning is critical. In step 6, it is critical to display the alternatives in a way that is clear and sensible.

Clear communication and understanding between the planner and the cooperator regarding the range of alternatives and the effects of implementing them must exist. In turn, this leads to intelligent choices that provide long-lasting benefits to biological resources.

Step 7 Make decisions

Decisions are the prerogative of the cooperator. The planner should provide sufficient information to assist and influence acceptable choices by the cooperator. Conservation planning is dynamic; it is an ongoing and likely lifelong process for the cooperator. On occasion, the cooperator takes a conservative approach to the plan that can lead to disappointment for the planner. Resist the urge to influence the cooperator to act outside of his or her comfort zone. Remember, it is his or her decision.

Example: A producer contacts the NRCS conservationist to request assistance on improving irrigation efficiency. The producer replaces an open ditch with a pipeline and engages in irrigation water management. From a wildlife perspective, there seems to be little benefit. However, the planner has a foot in the door and has planted the conservation seed. Perhaps the next logical step is the inclusion of a tailwater return system. The design of the sump for that system could benefit waterbirds, perhaps fish, and if adjacent cover is provided, small mammals.

Step 8 Implement the plan

The planner should work with the cooperator to adopt new ideas and concepts with the goal of finally implementing those ideas or practices on the land. Once the practices are applied to the land, the client will require support to ensure proper installation and management of the conservation practices. If cost-share programs are involved, the practice must be certified as meeting standards and specifications. All subsequent visits with the cooperator provide an opportunity to make adjustments relative to the management of the particular practice on the land.

Step 9 Monitor and evaluate

Monitoring and evaluation are another critical step in conservation planning. However, this step is one of the most neglected phases of the process. Monitoring must be integrated so that the cooperator and the planner know that the desired conditions are occurring on the land. Many cost and time effective monitoring tools are available.

One source is *Inventory and Monitoring of Wildlife Habitat* compiled by Allen Cooperrider, Raymond J. Boyd, and Hanson R. Stuart, available through the U.S. Department of Interior, Bureau of Land Management (September 1986). The reference has inventory and monitoring protocols for most major habitat types and for all vertebrate fish and wildlife species.

Example: One straightforward monitoring technique is photo monitoring. Cameras are inexpensive and easy to use. A date-back camera (where the date is printed on the photo image) is preferred. While a photo may not be quantitative data, it can contain a wealth of information. To assure that the responsible person can go back to the same locations, previous photographs must be in the planner's or cooperator's possession. Use of a 7.5-minute topographic map or global positioning system (GPS) ensures continuity of photo point location through time. Marking with rebar or flagging can also help ensure relocating fixed photo points.

Monitoring allows replanning—Like construction of a building from a blueprint, a conservation plan must invariably be modified. As the cooperator learns and acquires a more thorough understanding of the consequences of various management activities on the land, the natural progression is that the plan needs to be modified. It is a dynamic process. The application of the plan begins with the establishment and management of the array of conservation practices on the land. As the cooperator recognizes what is and is not effective, then modifications of both management and practices are often necessary.

611.05 Summary

The conservation plan enables the planner to engage cooperators, their beliefs, values, and attitudes relative to natural resource conservation. The planner then works with the cooperator to move toward a conservation ethic. However, the planner cannot be available at every step.

At some point, the cooperator will hopefully embrace a conservation ethic so that when the conservationist moves or retires, the cooperator will have the conservation ethic embedded as a way of life. Whatever conservation measures are applied to the land will benefit the land. That is the true value of the conservation plan and that is what the planner can expect as the ultimate outcome.

> *There are two ways to apply conservation to land. One is to superimpose some particular practice upon the pre-existing system of land-use, without regard to how it fits or what it does to or for other interests involved. The other is to reorganize and gear up the farming, forestry, game cropping, erosion control, scenery, or whatever values may be involved so that they collectively comprise a harmonious balanced system of land use.*
>
> **Aldo Leopold**
> Coon Valley: An adventure in
> Cooperative Conservation
> (1935)

Subpart B Conservation Planning

Part 612 Fish and Wildlife Habitat in Ecological Site Descriptions

To be issued at a later date